STUDIES IN THE GEOGRAPHY OF LEPIDOPTERA.

By E. P. Wiltshire, F.R.E.S.

In subsequent articles in this series the author hopes to deal with species or ecofaunas, but in this, first, introductory article, he brings forward some of his general conclusions reached after at least ten years' field work abroad and relevant reading, and also a shorter period of field work in this country.

I.—TYPES OF EVIDENCE FOR HISTORICAL THEORIES.

Every creature's range has been determined by ecological factors and also by historical factors, recent or geological. Historical factors, as a matter of fact, are only ecological factors not contemporary, and, therefore, not possible to study as closely as contemporary ecological factors.

Palaeontological evidence is the best basis for the reconstruction of the past history of plants or animals, but it is not the only possible basis. A tentative reconstruction may also be based on taxonomic grounds, that is, from a comparison between their present distribution and their structural classification; or alternatively on ecological grounds, that is, from a comparison between their present ecology and the known geological history of the regions involved.

Since adequate palaeontological evidence of Lepidoptera has not been and probably never will be discovered, zoogeographical studies of Lepidoptera should, if possible, be based on both these alternatives.

The palaeobotany and palaeontology of the Tertiary and Recent epochs must be studied, so that the migrations, appearances and extinctions of the successive floras and faunas may afford analogies for the Lepidoptera under consideration. Since flowering plants first appeared in the Cretaceous, and the earliest known lepidopterous fossil is from Eocene strata, a knowledge of remoter epochs is not strictly necessary. In default of palaeontological evidence, direct proof of the reconstructed history will be lacking, and in Lepidoptera probably the best that can be hoped for is that the conclusions based on the above diverse alternative grounds should agree; that would be circumstantial evidence of a persuasive kind.

Evidence based on ecological analogy becomes less valuable for deductions involving a remoter period; for the ecological valency of a species presumably evolves simultaneously with its taxonomic characters, and the ecology of the remoter ancestors of a species cannot be as safely inferred from its known ecology as can that of the more immediate ancestors. It is not, however, unreasonable to suppose that an ancestor, if still specificially identical with its present descendant, had a similar ecology; indeed, Warnecke has called this supposition "the indispensable postulate" underlying all zoogeographical speculation. In certain cases, where a taxonomic group of species is sharply characterised ecologically (e.g. the hydrophytic-boring group *Phragmitiphila-Archanara* (*Nonagria*) or the genus *Clytie*, which is monophagous on the genus *Tamarix*) a similar assumption can be made about closely related but not necessarily identical ancestors. Rarely, if at all, in Lepidoptera can the ecology be inferred from the structure of a fossil as it often can be in other Phyla or Orders.

For genera or groups whose living members show a wide ecological diversity, therefore, the only available grounds for historical theories covering the Tertiary Epoch are geographical and taxonomic evidence and the mere analogy of general floral and faunal histories. Dr Verity's theories would seem to be so grounded. Dr Beirne's theories, which do not try to go so far back, have a similar basis, except that the emphasis is rather on the geographical and geological than the taxonomic evidence. For groups sharply characterised ecologically, ecological analogy would be a good additional basis for theorisation.

Most of such theorisation is at present impeded by our lack of full ecological evidence for the forms and species under consideration and by the lack of adequate geological evidence regarding all the regions involved. These objections do not apply to Dr Beirne's findings, which are confined to regions well studied geologically and comparatively well studied ecologically. While it is most improbable that enough butterfly or moth fossils will be discovered to provide factual proof of lepidoptera-histories, it is not unreasonable to hope that one day our geological and ecological data will render far-reaching theories less speculative.

If the above general principles are sound, the following will be the more fruitful directions of activity for lepidopterists interested in zoogeography:—Firstly, taxonomic studies with the aim of grouping phylogenetically the geographical forms of a species and the different species of a group; secondly, ecological studies, determining the limiting factors of each species and defining the biotope or biotopes in which it is found and its status in each; thirdly, the exploration of little known regions with the aim of drawing up faunal lists in which taxonomic and ecological accuracy is essential. On the negative side, these lepidopterists should firstly refrain from wasting their energies drawing up local lists of well-known territory without ecological precision, and, secondly, should restrict their historical theories to the Pleistocene Epoch or to groups with a well-characterised ecology. The geography of Lepidoptera can also make little progress without the co-operation of the geologist abroad, especially in the close study of Tertiary and Recent rocks and deposits, our knowledge of which is still very defective. Finally, the lepidopterist-geographer must to a great extent resign himself to laying the ground-work for the future historical reconstructions that cannot at present safely be made.

SUBSTITUTE FOOD-PLANTS.

By D. G. Sevastopulo, F.R.E.S.

Mr Wiltshire's recent article under this title in this Journal (1943, lv, pp. 79-85) has tempted me to classify the hundred and thirty odd species of Lepidoptera that I have bred in Calcutta during the last few years, and whose food-plants have been identified, on similar lines and see if they would also fall into tidy groups. The results were interesting: 136 species were involved and fed on 70 different food-plants; of these 100 species feeding on 42 different plants could be connected by starting from one plant and listing the species feeding on it, then taking the other food-plants of these species and so on. It is possible that an even